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DRAWINGS ATTACHED

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(54) PRINTED WIRING PANELS

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of manufacturing a printed wiring panel and to a printed wiring panel manufactured by such a method.

It has previously been proposed to manufacture a printed wiring panel by a method in which a substrate made of a curable phenol-formaldehyde or cresol-formaldehyde resin reinforced by at least two paper sheets is provided on either side with a metal foil, the assembly is then heated, whilst compressed, so that a satisfactory adhesion between the metal foils and the substrate is obtained and the resin is partly cured, and the metal foils are subsequently covered in known manner with a protective lacquer layer, according to the desired wiring pattern and the uncoated metal parts are etched away, after which the substrate is split parallel to the surface into two sheets and each sheet is fastened in known manner, whilst compressed and simultaneously heated, to a supporting body, the wiring being pressed into the synthetic support and the resin being cured completely.

During the investigations which led to the present invention, it was found that this method may be modified so that a substrate is used which consists of an epoxy resin reinforced by at least two layers of glass tissue, the results produced being quite satisfactory. This result was unexpected, since whereas paper is compressible, glass tissue is not compressible or is substantially incompressible. However, it appeared to be possible to press the wiring into the surface of an epoxy resin substrate reinforced by glass tissue without the pattern of the tissue becoming visible in the copper tracks. It was found that even very fine tracks do not shift in place during compression, for example, by sliding off the comparatively thick glass threads of the tissue.

The present invention provides a method of manufacturing a printed wiring panel, comprising the steps of forming an assembly consisting of a curable epoxy resin substrate, reinforced with at least two layers of glass tissue, sandwiched between two metal foils which are each coated with an adhesive on the surface which abuts the substrate, then heating the assembly under pressure so that the metal foils adhere to the substrate and the epoxy resin is partly cured, then forming a protective lacquer over each metal foil which corresponds to the desired wiring pattern, then removing the exposed metal foil by an etching treatment, then splitting the substrate parallel to its surface into two sheets so that each sheet contains at least one layer of glass tissue, and attaching at least one of the sheets to a supporting body by a heating and pressing operation whereby the wiring is pressed into the sheet and the epoxy resin is completely cured.

An embodiment of the present invention will now be described with reference to the accompanying diagrammatic drawing, in which:

Figures 1 to 5 show at consecutive stages of manufacture, cross-sectional views of an insulating layer to which metal layers or metal patterns are applied, and

Figure 6 is a cross-sectional view of one panel made by this method.

Two layers of glass tissue 1, impregnated with an epoxy resin, are joined so that they form a substrate 2, on either side of which substrate 2, metal foils 3 and 4 respectively, which are, for example, made of copper, are disposed (Figure 1). Suitable epoxy resins are all resins appropriate for the impregna-

[Price 5s. 0d. (25p)]

tion of glass tissue and are commercially available for this purpose, for example, epoxy resins based on bisphenol A or novolak type resins.

The copper foils 3 and 4 are between 20 and 80μ, for example, 35μ thick. A metal other than copper may be chosen for these foils, for example, aluminium or nickel. The copper foils 3 and 4, before they are applied to the substrate 2, are each provided on the surface which will be adjacent to the substrate 2, with an adhesive coating. Suitable adhesives which may be used to form the adhesive coating are adhesives of the type consisting of a mixture of a phenol-formaldehyde or cresol-formaldehyde resol resin with an acrylonitrile-butadiene copolymer; the adhesive used may be an epoxy resin which may be mixed with an elastomer.

The substrate 2, the various layers of which are shown in Figure 1 separated from each other for the sake of clarity, and the metal foils 3 and 4 applied to either side thereof, are compressed in a press heated at about 150°C for about 5 minutes. This heat treatment partly cures the epoxy resin so that sufficient adhesion is obtained between the substrate 2 and the copper foils 3 and 4 to form a cohesive assembly 20 which can be handled conveniently.

Then each of the copper foils 3 and 4 of the assembly 20, are respectively provided with etching resist patterns 21 and 22 (Figure 2) in accordance with the positive of the desired conductive pattern. This may be achieved by printing the resist pattern by means of a silk screen stencil directly on the surface of the metal foil concerned. In the case of detailed patterns, the resist pattern is preferably applied photographically in which case the whole surface of the copper foil is first coated with a layer of a photo-hardening material, for example, a photo-sensitive bichromate polyvinylbutyral lacquer layer, which photosensitive lacquer layer is exposed in accordance with the desired conductive pattern to acinic light, after which the non-exposed parts of the laquer layer are dissolved or washed away.

The assembly 20, provided with the resist pattern is then dipped into an etching solution, in which the portions of the copper foils 3 and 4 not covered by the resist layers 21 and 22 respectively are dissolved. The etching solution may consist of a ferric chloride solution. After the etching process, the assembly is washed and the resist patterns on either side of the assembly are removed by means of an alcoholic solution of hydrochloric acid, so that an insulating assembly 20 is obtained, which is provided on either side with a pattern formed by the remaining parts 31 and 32 respectively of the initial foils 3 and 4 on the surface (Figure 3).

After washing and drying, the assembly 20 is split parallel to its surface (Figure 4) so that two separate insulating sheets 41 and 42 are obtained, each of which comprises a layer of glass tissue impregnated with partly cured epoxy resin, provided on one side with an adhering copper pattern 31 or 32 respectively.

One of these sheets, for example, the sheet 41 is applied to an insulating supporting body 51, which is made, for example, of a completely or partly cured epoxy resin, which may be reinforced by glass fibre in the form of a mat or a tissue. The stack thus obtained is placed in a press 50 (Figure 5) and compressed, whilst heated, the copper pattern 31 thus sinking into the sheet 41 and the epoxy resin in this sheet being completely cured. At the same time an adhesive joint is established between the sheet 41 and the supporting body 51. If the latter contains partly cured synthetic resin, this resin is completely cured at the same time.

The press 50 thus delivers an insulating panel 61 (Figure 6), in which the epoxy resin is completely cured and which is provided with a conductive pattern 31 sunk into the surface.

The sheet 42 may be joined in a similar manner to a further supporting body 51.

It will be obvious that the supporting body 51 to be introduced into the press 50 may be provided on either side with an insulating layer obtained by splitting up an assembly 20 and having a pattern lying on it, for example the sheet 41 on the upper side and the sheet 42 on the lower side. The pressing operation then provides a panel having on either side a conductive pattern sunk into the panel surfaces. These patterns need not be identical.

In view of the subsequent splitting, the substrate 2 contains at least two glass tissue layers and is in general chosen to be as small as possible.

In a practical case the thickness of the metal foil was 35μ and the thickness of each of the glass tissue layers was 200μ. The glass tissue layers were impregnated with an epoxy resin produced from epichlorohydrine and bisphenol A.

The small thickness and the resultant flexibility of the thin insulating sheets 41 and 42, obtained after the splitting operation, and having a metal pattern on their surfaces, makes it possible to manufacture panels having a shape different from the flat plane. The insulating sheet or sheets may be compressed, for example, together with a deformable supporting body 51 in a specially shaped, for example, semicylindrical press, and cured. The supporting body 51

may, however, also consist of substantially non-deformable material, but it then has to be shaped previously into the desired, non-flat form, which form is then matched by the insulating sheet(s) 41 and/or 42 bearing the copper pattern in the press. As a matter of course, the shape of the press tool then also has to match the desired shape of the supporting body.

The present invention provides the advantage that the support can be provided with very narow, conductive tracks. This allows the manufacture of a compact structure. The tracks may be less than 0.1 mm. wide. With substrate material in which the wiring is not pressed into the surface, this value is not attainable. It is found that in soldering and resoldering very narrow tracks, the wiring becomes loosened from the substrate; moreover, it may shift in place across the surface. This is due to the substantially unavoidable undercutting of the tracks, to an extent which may be 20 to 30%. In the case of very narrow tracks, it affects the adhesion to a considerable extent. With the product according to the present invention such a shift is not possible, since the wiring is embedded in the surface.

A further advantage resides in that etchants cannot penetrate into glass tissues impregnated with an epoxy resin. Consequently, subsequent to the etching process there is no need for removing the edge from around the panel, which is necessary with a substrate of paper impregnated with a phenol-formaldehyde resin.

As a matter of course, the present invention otherwise provides the same advantages as the previously proposed method. These consist particularly in that two wirings completely independent of each other are obtained in a single etching process, whilst during etching the surface of the partly cured support is protected from the etchant by the layer of adhesive.

WHAT WE CLAIM IS:—

1. A method of manufacturing a printed wiring panel, comprising the steps of forming an assembly consisting of a curable epoxy resin substrate, reinforced with at least two layers of glass tissue, sandwiched between two metal foils which are each coated with an adhesive on the surface which abuts the substrate, then heating the assembly under pressure so that the metal foils adhere to the substrate and the epoxy resin is partly cured, then forming a protective lacquer layer over each metal foil which corresponds to the desired wiring pattern, then removing the exposed metal foil by an etching treatment, then splitting the substrate parallel to its surface into two sheets so that each sheet contains at least one layer of glass tissue, and attaching at least one of the sheets to a supporting body by a heating and pressing operation whereby the wiring is pressed into the sheet and the epoxy resin is completely cured.

2. A method as claimed in Claim 1, wherein the supporting body consists of glass fibres in the form of a mat or a tissue impregnated with an epoxy resin, and wherein the epoxy resin in the supporting body is initially in the partly cured state and is completely cured during the step of attaching at least one of the sheets to the supporting body.

3. A method as claimed in Claim 1 or Claim 2, wherein at least one of the sheets bearing a wiring pattern is shaped in a press in a configuration differing from a flat plane, and in which configuration the epoxy resin in the sheet is fully cured.

4. A method as claimed in Claim 1 and substantially as herein described with reference to the accompanying diagrammatic drawings.

5. A printed wiring panel manufactured by a method as claimed in any preceding Claim.

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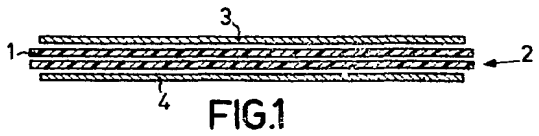

FIG.1

FIG.2

FIG.3

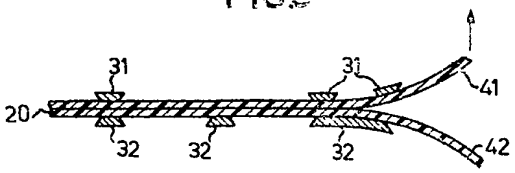

FIG.4

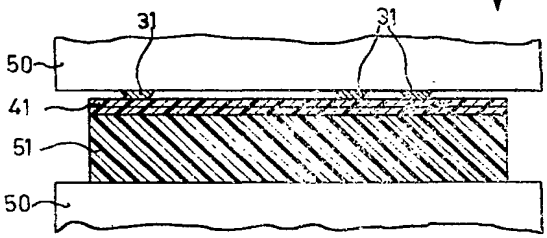

FIG.5

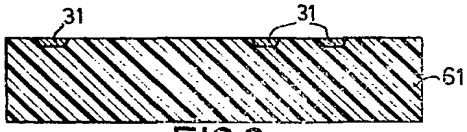

FIG.6